

## TECHNICAL SPECIFICATIONS – HVAC WORKS

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## **1.0 GUIDE LINES**

### **1.0 SCOPE**

1.1 The scope of this section covers guidelines for the contractor on the specification and schedule of material and the general requirements.

### **2.0 SCOPE OF CONTRACT**

2.1 The scope of work under this contract covers supply of equipment, material & accessories and labour required for the specified works and to carry out the erection testing & commissioning as specified and shown on the drawing and schedule of material.

2.2 Safety, good workmanship, quality and timeliness are the prime requisites of the work covered under this contract. All the equipment, material and the works carried out shall meet the relevant codes, the intent of specifications and the proper functioning of the systems and installation and shall be as per industry standards meeting all statutory requirements and shall be in correct lives levels, aligned etc.

2.3 The scope of contract shall also cover all taxes and duties, loading and unloading, packing and forwarding, watch and ward, insurance etc. up to commissioning & hand over.

### **3.0 DIVISION OF WORK**

3.1 The division of work by the contractor and other agencies shall be as specified under Sub-Section 10.0 of Section: 2 System Design & Division of Work.

### **4.0 MATERIAL**

4.1 The equipment's and material shall meet the specifications and requirements indicated in the technical specifications covered under specific section and the relevant equipment data.

4.2 The makes of material shall be one of the recommended makes covered under Section: 4 Makes of Material. However, when makes are specified in the BOQ, the first mentioned make shall be considered. Only if the first mentioned make is not available shall the consultant and client accord approval for considering the 2<sup>nd</sup> & similarly the 3<sup>rd</sup> mentioned make.

### **5.0 SPECIFICATION**

5.1 The technical specification given below gives general guidelines and minimum standards for equipments, material and workmanship. However, it is the responsibility of the contractor to meet the statutory provision and local codes.

### **6.0 SCHEDULE OF WORK**

6.1 The schedule of work indicates the scope and quantity of the work estimated at the time of preparation of this tender. The quantities indicated are based on rough estimate on the basis of the drawings and subject to variation due to site condition.

6.2 Also additional requirements, deletion or replacement of items may arise during the installation. Hence there shall be variation in quantities indicated. However, the unit rates quoted shall remain firm during the contract period.

### **7.0 STANDARDS & REGULATIONS**

7.1 Each section indicates the Indian Standard Specification to be followed. It is the responsibility of the contractor to meet the statutory regulation local codes and other relevant standards and specifications connected to the work being carried out.

## 8.0 INSPECTIONS & TESTING

8.1 The Consultants/Clients have the right to inspect the plants, equipments and materials at manufacturer's work or at site at any stage and reject the materials that are substandard or do not meet the requirements of the specification makes and codes.

8.2 The contractor shall provide at his cost at site and elsewhere instruments and appliances for testing the equipments and installation at various stages of manufacturing/installation. These instruments shall be got tested and calibrated for their accuracy and performance from the approved institutions.

8.3 The inspection and testing carried out by the Consultants/ Clients/Third party does not relieve the contractor of his responsibility of carrying out routine inspection during each stage of procurement, manufacture and installation and also meeting the intents and requirements of the specification and statutory requirements.

8.4 All equipments and the installation to be retested in the presence of the Consultants/Clients after carrying out necessary rectification, adjustments and balancing. Four sets of test readings should conform to the specification, equipment data, standards and codes.

## 9.0 TRAINING

9.1 The operating staff of the Client shall be trained free of cost for the operation, maintenance overhauling etc. of the equipments and installation.

## 10.0 STATUTORY INSPECTION

10.1 The contractor shall be fully responsible for meeting all the statutory obligations and local inspectorates pertaining to the works carried out by him. The contractor should prepare all working drawings and obtain approval of competent authorities and also have the equipment and installation inspected and got approved.

10.2 All official fees will be paid by the Clients directly against demand in writing from the appropriate authorities and all other expenses for submission and approval of the various relevant statutory bodies shall be embodied in the tender prices. Contractor shall also carry out the necessary liaison work with the statutory bodies / institutions / company on Client's behalf.

## 11.0 DEVIATIONS

11.1 Should the tenderer wish to deviate from the provision of specification and drawings; the same shall be indicated separately along with supporting drawing and specifications to decide the merits of such deviation. In the absence of any deviation it is deemed that the tenderer is fully satisfied with the intents of specification and drawings and their compliance with the statutory provisions and codes.

11.2 However, the offer shall be strictly on the basis of tender specification and schedule of material. The offer for the deviated items shall be furnished separately.

## 12.0 REFERENCE DRAWINGS

The drawings issued with the tender as mentioned in Section: 3, are basic schematic drawings and are part of the tender documents. These represent a feasible scheme for the optimum capital and operational costs. Should the Contractor find any modifications are required, the same shall be brought with proper supporting computations and approval of the same shall be obtained, in writing, from the Services Consultant, before execution. Contractor shall preserve one set of this drawing in good condition incorporating all modifications carried out from time to time during the erection period at the site and shall return them to the Consultant/Architect/Clients after completion of the work. Separate 'As Executed' drawings to be submitted.

### 13.0 WORKING DRAWINGS

13.1 Contractor shall prepare execution drawings and get them approved by the Consultant before carrying out the execution, modify the drawings, if required, to suit the site conditions and get the approval. The execution drawings shall contain all details of finishes, levels and sections. The approval of the drawings does not relieve the contractor of their responsibility of meeting the intents and requirements of the specification and statutory requirements.

13.2 The contractor shall submit the followings details within 10 days of award of the contract.

- (a) List of equipments and the power requirements.
- (b) Foundation drawings and structural support details for foundations & supports for equipment to be provided by the civil contractor.
- (c) Any other civil, structural, electrical or plumbing requirement.
- (d) Bar chart for proper execution of the work along with cash flow statement.
- (e) List of working drawings that the Contractor proposes to make

13.3 On completion of the installation, the contractor shall prepare and submit AS EXECUTED drawing incorporating all modification carried out during the execution.

### 14.0 MEASUREMENTS AND PAYMENTS

14.1 The mode of measurement and payment shall be strictly indicated under Section: 5 Measurements and Payments. This indicates the mode of measurement, items to be included and items excluded etc. in a board basis. However, it is the responsibility of the contractor to meet the intents of the specification and total installation on the works contract/turnkey basis.

### 15.0 HANDING OVER

15.1 The installation shall be handed over after satisfactory testing along with the following documentation.

- a) Three sets of prints of the As Installed "AS BUILT" drawings along with 2 sets on CDs.
- b) Two sets of test readings duly certified by the SERVICES Consultant.
- c) Four sets of detailed equipment data and operation and Maintenance manuals.
- d) List of recommended spares for 2 years of trouble free operation.
- e) Performance guarantee in the prescribed form.

15.2 The final acceptance shall be effective only after the submission of the above documents as also Performance Test. Final payment will be released only after the handing over and submission of documentation.

### 16.0 PERFORMANCE GUARANTEE

16.1 All equipment and the entire installation shall be guaranteed to yield the specified ratings and design conditions with a plus / minus 3% tolerance. Any equipment found short of the specified ratings by readings shall be rejected. Contractor to replace these at his cost after providing for stand-in equipment.

### 17.0 POWER SUPPLY

17.1 Power will be made available at 415/240V, 3 phase, 4 wire 50 CPS earthed neutral system and all equipments shall be suitable for the above power supply with a variation of plus/minus 10%. The Split Units shall operate on 230V, Single Phase, 2 wire AC supply. Any equipment / component operating at other than the above power supply shall be provided with necessary transformer at the cost of the HVAC Contractor.

## **2.0 SYSTEM DESIGN & DIVISION OF WORK**

### **1.0 SCOPE**

- 1.1 The scope under this section shall cover the system design & the scope of the Work.
- 1.2 The scope of work shall cover the following:
  - a) SITC of ChW TFA AHUs
  - b) SITC of ChW Fan coil units
  - c) Extension of Chilled Water piping to extended floors 8<sup>th</sup> to 11<sup>th</sup> & to respective equipment at each floor
  - d) Chilled Water Piping Insulation
  - e) Air Distribution with ducting, dampers, grilles and diffusers, louvers & insulation work

### **10.0 DIVISION OF WORK**

The division of work between the HVAC works contractor and others shall be as mentioned below:

The division of work between the air-conditioning contractor and others shall be as mentioned below.

#### **10.1 BY HVAC CONTRACTOR.**

1. Insulated Chilled Water Piping extension.
2. ChW TFA AHUs
3. ChW FCUs
3. Ventilation and Exhaust Fans
5. Electrical Panels & cabling (for AHU, Fans etc.)
7. Insulated Drain Piping.
8. GI factory boxed ducting, supports & hangers.
9. Thermal & Acoustic Insulation of Ducts and Piping
10. Acoustic lining of Ducts, Partition walls, AHU Rooms/ Trap Doors
11. Minor civil works including wall openings for pipes, ducting, cabling etc. as required & making good / sealing of those. Final finish shall be under interior scope.

#### **By Other agencies (in coordination with and under direct supervision of HVAC Agency)**

##### **a. Electrical Works:**

1. Provision & Termination of main power supply and earthing to all Panels / Equipment's.
2. Switch and socket outlet within one-meter distance of fan coil units, inline fans and hiwall split AC units.

##### **b. Plumbing Works:**

1. Drain connection for AHU after floor drain points with 'P' traps. (Floor drains with traps shall be provided in each AHU room by the Plumbing agency)

##### **c. Civil Works, False Ceiling & Carpentry:**

1. Boxing and false ceiling works.
2. Any slab, structural changes / major openings in masonry and breaking up in the existing structure & making good.
3. Final finish & painting of openings done for HVAC purpose.
4. False ceiling works, cut-outs in false ceiling for grilles and diffusers.
5. Foundations
6. Insulated airtight boxing

All above exclusions are applicable only if they are informed in writing and after obtaining written instructions from the Consultant / Architect within 21 days of issue of work order / LOI, failing which these shall be deemed to have been included by the HVAC contractor.

### **3.0 REFERENCE DRAWING**

#### **1.0 SCOPE**

1.1 The scope under this section covers the basic drawings and details to understand the following:

- Scope of work.
- Location of equipments.
- General idea on the entire installation.
- Material requirements and specification requirements for the completion of work in the stipulated time schedule.

1.2 The reference drawings attached with the tender are schematic to provide a general understanding of the requirement and are prepared on the basis of preliminary requirements and data available. They are subject to undergo changes and modifications subject to the finalisation of details and requirements of the clients.

Following Scheme Drawings are issued as part of the Tender Documents:

<b>S.No.</b>	<b>Dwg. No.</b>	<b>Description</b>
1	1679-AC-01	Schematic ChW Piping for extended floors
2	1679-AC-02	HVAC Layout for Typical Patient Floor (Extended Floors)

1.3 The detailed working drawings and the drawings required for the submission to statutory authorities shall be the responsibility of the HVAC Low Side Works contractor. The Contractor shall submit minimum six copies of the following drawings to the Consultants for their scrutiny / approval before issuing to the statutory authorities and site for execution.

#### **2.0 NUMBERING OF SHOP DRAWINGS:**

Any additional Shop Drawings & Detailing as required for the proper execution of the project shall be the responsibility of HVAC Low Side works Contractor & these drawings shall be submitted for prior approval from the consultant before execution of works.

All shop drawings submitted by the Contractor shall be properly numbered. GFC drawings issued by the Consultant shall only be used by the contractor for preparing shop drawings.

#### **4.0 MAKES OF MATERIAL**

##### 1.0 SCOPE

1.1 The scope of this section covers the recommended makes of equipments & material components. The final choice of makes shall be indicated at the time of making the initial offer.

1.2 The makes of material offered by the contractor shall be indicated at the space provided for proper evaluation of the offer and shall be one of the recommended makes. In the absence of such indication, the decision rests with the Consultants / Clients.

1.3 When makes of material are mentioned in the BOQ, these shall supersede the list.

1.4 Items for which makes are not recommended, contractor shall obtain approval from Consultant prior to procurement.

##### 2.0 MAKES RECOMMENDED

2.1 The makes of material recommended are as shown below. The offers shall be strictly on the basis of the makes underlined. However, the bidders can offer alternative makes as a deviation. Such deviation shall be substantiated with technical literature of the material/equipment offered.

The scope of this section covers the recommended makes of equipments and material components. The tenderer shall quote his rates on the basis of the price of the brand /make stipulated in the item of works as described in BOQ, specifications and furnished in Summary Sheets/Technical data.

The owner reserves the right to select any of the brands indicated in the "List of Approved Makes". In case of delay in delivery of ordered 'make of item'.

The contractor cannot claim anything extra if the owner changes the make within the list of approved makes. Items for which makes are not recommended, contractor shall obtain approval from Consultants prior to procurement.

ITEM	APPROVED MAKES
<b>Refrigeration Machines:</b>	
Water-cooled Centrifugal Chillers with VFD / Centrifugal Oilfree Magnetic Bearing Chillers with R134A / R-514A/ R-1233zd	Trane, York, Daikin, Carrier, Kirloskar, Clima Veneta
Air-cooled Screw Chillers (R134A / R513A)	Trane, York, Daikin, Carrier, Kirloskar, Clima Veneta
Air-cooled Split AC Units (min. 5 star-Hi-wall) R32 refrigerant	Daikin, Mitsubishi Electric, Toshiba, Bluestar, Voltas, Carrier
Air-cooled Ductable / Package Units (R410A)	Voltas, Bluestar, Carrier, Daikin, LG
Water-cooled Ductable / Package Units (R410A)	Voltas, Bluestar, Carrier, LG
Air-cooled VRF System (R410A)	Daikin, Mitsubishi Electric, Toshiba, Bluestar, Voltas, Carrier, LG

ITEM	APPROVED MAKES
Water-cooled VRF System (R410A)	Daikin, Mitsubishi Electric, Toshiba, Bluestar, Voltas, Carrier, LG
Air-cooled Precision AC Units / Chilled Water Precision AC units	Stulz, Vertiv, Schneider, Clima Veneta
<b>Pumps &amp; Pumping System:</b>	
Pumps	Xylem-ITT, Grundfos, Armstrong, Wilo
Variable Speed Pumping System: (Pumps, VFD with bypass arrangement & DP sensor/transmitter & Pump Controller)	Proprietary from Secondary pumping system Mfg - Xylem-ITT, Grundfos, Armstrong, Wilo
<b>Cooling Towers:</b>	
Cooling Towers:	Advance, Mihir, Paharpur, Flowtech, Bell, Nihon Spindle, Marley, Delta
Evaporative Cooling Section	DRI, ATE
<b>Double Skin AHUs &amp; Heat Recovery Unit:</b>	Systemair, Citizen, Flaktwoods, VTS Clima, Edgetech
EC fans with EC Motors IE4 / IE5	Zeihl-Abegg, EBM-Papst, Rosenberg
Plug Fans	VTS-Clima, Kruger, Systemair, Nicotra
Centrifugal Fans Direct Drive	Kruger, Nicotra, Blowtech, Humidin, Systemair, Greenheck
Sq.Cage Motors: (minimum IE3)	Siemens, ABB, Crompton
<b>Heat Recovery Wheel</b>	DRI, Flaktwood, Eventus
<b>Double Skin Plenums</b>	from AHU OE, Advantech, Edgetech, VTS Clima, Citizen
<b>Ductable Fan Coil Units</b> with extended tray & factory supplied valve station kit	Kubic-Midea, Bhutoria, Cruise
<b>Variable Frequency Drives:</b>	Danfoss-HVAC, ABB HVAC, Fuji-HVAC, Yaskawa HVAC
<b>Fans:</b>	
Axial Fans	Kruger, Systemair, Dynair, Nicotra, Greenheck, Flaktwoods
Inline Ducted Fans, Cabinet Fans	Kruger, Nicotra, Caryaire, Ostberg, Systemair
Propeller Fans	Alsthom, Havells, Caryaire, Kruger, Almonard



ITEM	APPROVED MAKES
Jet Ventilation Fan for Car parking	Dynair, Kruger, Systemair, Nicotra-Gebhardt, Flaktwoods
Destratification Fans	Airius
HVLS Fans	Nutech, RR, Kelley
<b>Air Distribution:</b>	
GS sheets - LFQ as per IS 277 - Class VII-120 GSM / 180 GSM	Jindal, SAIL-Bhilai, Tata Steel, Posco
Prefabricated Factory boxed GS Ducts	ASAWA, Duct-O-Fab, Radiant, Sevenstar, Western Airduct
Flat oval Spiral / Round spiral Ducts	ASAWA, Duct-O-Fab, Radiant, Sevenstar, Western Airduct, GP Spira
Insulated flexible ducts	UP Twiga, ATCO, Sevenstar, Titus
Insulated PIR Facory Made Boxed Ducts	ASAWA, MechEasy, Zeco
Fire & Smoke Dampers as per UL-555S certified & stamped	Ruskin, Systemair, Greenheck
Fire & Smoke Dampers as per UL-555S	Cosmos, Airmaster, Caryaire
Dampers, Louvers, Motorised Dampers, Fire Dampers (CBRI Approved)	Dynacraft, Cosmos, Airproducts, Airmaster, Caryaire, Tristar, Cosmic
Constant Air Volume Regulators	Aldes, Systemair
Grills, Diffusers, Aluminium Box Type Dampers, Jet Nozzles, Fan powered grills with EC fan	Dynacraft, Cosmos, Airproducts, Airmaster, Caryaire, Tristar, Cosmic
Circular GI Spigots with damper & locking arrangement	Dynacraft, Cosmos, Airproducts, Airmaster, Caryaire, Tristar, Cosmic
Exhaust Disc Valves and Door Transfer Grille	Dynacraft, Cosmos, Airproducts, Airmaster, Caryaire
Damper Actuated Motors with Control Panel	Belimo, Joventa, Honeywell
Air Filters	Camfil-Farr, AAF, Thermadyne, Dynafilters
Variable Air Volume (VAVs) / Constant Air Volume (CAV)	Cosmos, Airproducts, Honeywell, Syncro, Tristar, Caryaire, Airmaster
Variable Air Volume (VAVs) imported	Trox, Systemair, Trane, Barcol Air
VAV actuators Controllers	Honeywell, Delta, Belimo, Distech
Routers, Interface, Integrator	Honeywell, Delta, Distech
Duct Sound Attenuators	Kruger, Cosmos, Tristar, Aldes, Greenheck
Flexible Duct Connector	Easyflex, Mapro, Resistoflex, Kanwal

ITEM	APPROVED MAKES
Bi-polar Ionisers	NE-Ion-Pure, EMI-EMC,
UVGI C Lights & Control Panel for AHUs	Aeropure, Alfa-UV, NE-UVI-Pure, Philips
Air Curtains	Euronics, Systemair, Russell, Mitsubishi
Air Purification System	Citizen, Systemair, Edgetech; EC Fans: EBM-Papst, Zeihl-Abegg, Rosenberg;
Fresh Air Measuring Station	Cosmos, Kele
<b>Refrigerant Piping:</b>	
Copper pipes & Fittings	Nippon, Bundy, Mandev, Nissan, Rajco, Mexflow, RR, Hariom, Uniflow
<b>Water Distribution:</b>	
Pipes	Tata, Jindal, Zenith, Surya, SAIL
MS/CS Fittings	RR, KS, Venus, Shah Bhogilal, Kirti
Butterfly Valves	Intervalve, Audco, Advance, Shakti, Bonomi Ventiel, VTM / Uttam Valves, Pentair Valve (Keystone), KITZ, Honeywell
Motorised Butterfly Valves	Belimo, Honeywell, Danfoss
2-way ON/OFF Motorised Valves with actuator, controller and sensor/thermostat	Honeywell, Belimo, Schneider, Sauter
2-way Modulating Motorised Valves with actuator, controller and sensor/thermostat	Honeywell, Belimo, Schneider, Sauter
PIBCV / PICV	Danfoss, Flowcon, T&A, Honeywell, Belimo
Ball Valves (3 Piece)-upto 40mm	Audco, Leader, Zoloto, RB, Bonomi, Belimo, Danfoss, Honeywell, Giacomini, Advance, Uttam / VTM
Ball Valves with strainer- upto 40mm	Audco, Leader, Zoloto, RB, Bonomi, Belimo, Danfoss, Honeywell, Giacomini, Advance, Uttam / VTM
*Fan coil units shall be with factory supplied Valve station Kit by OE.	
Air release valves	Spirovent, Leader, Anergy, Caleffi, Reflex
Balancing Valves (Manual)	Advance, Danfoss, Castle
Non-Return Valves	Intervalve, Advance, Leader, Castle, VTM / Uttam Valves, Danfoss, Honeywell
Globe/ Gate Valves	Leader, Zoloto

<b>ITEM</b>	<b>APPROVED MAKES</b>
Pot / Y Strainers	Trishul, Leader, Sant
Expansion Bellows	Fluidyne, Sigmaflex, Cori, Kanwal, RMS Corp.
Magnetic Particle Collector (Line Separator)	Electroflux; Caleffi, Reflex
Sight Glass	Spirax, Leader
Pressurised Closed Tank and Air separator with booster pump	KD Agencies, Anergy, Caleffi, Reflex, Xylem-ITT
Suction Guide	KD Agencies, Anergy, Xylem-ITT-Bell & Gossett
Suction Deareators and Dirt Separators	Spirovent, Caleffi, Reflex
Pressure Maintaining System	Anergy, KD Agencies
Drain Pumps	Aspen
Drain piping	Prince, Astral, Ashirwad, Supreme
<b>Controls and Instruments:</b>	
Pressure Gauges	Waree, Pioneer, Baumer
Thermometers	Waree, Pioneer, Baumer
Flow Switch, Pressure Switch	Danfoss, ALM Systems
Test Ports	Anergy, ALM
DP Sensor	Dwyer, Omicron
DP Controllers	Vemco, Schneider, Siemens
<b>BMS:</b>	Compatible to Central BMS / IBMS & with Modbus RTU, BACnet, Lonworks protocol)
Sensors, CO2 sensors, Controllers, Monitors, Thermostats, Temp. Indicators (Low side)	Honeywell, Carel, Belimo, Schneider
Air flow meters	Honeywell, Ebtron
DP sensors	Dwyer, ALM, Siemens
IAQ Sensors	Honeywell, Kaiterra, Greystone, Belimo
BTU Meters	Honeywell, Kamstrup, Onicon, AdeptFluidyne
DP Controllers	Vemco, Honeywell, Schneider
<b>Insulation:</b>	
<b>Thermal Insulation:</b>	
Overdeck Insulation- XPS	Owens-Corning, UP Twiga, Llyod Insulation, Kimmco, Thermoshield, Isoboard
Ch.W. Piping HD-EPS (TF quality)	Beardsell, Modifoam, Coolite, Styrene Packaging

<b>ITEM</b>	<b>APPROVED MAKES</b>
Ch.W. Piping Class 'O' Closed Cell, Nitrile Foam (Closed Cell) for ducting, piping & floor insulation – with Anti-Microbial Property	Armaflex, K-flex, Aerocell
EPDM – ASTM E84	ALP Aeroflex, Armaflex-USA, K-flex-USA
XLPE Cross Link	Trocellen, Thermobreak-Sekisui
AL cladding on insulation (24G)	Hindalco/Indalco
Fibreglass (Al.foil faced)	UP twiga, Owens Corning, Llyod Insulation, Kimmco
Rockwool	Saint-Gobain
Cold Compound / CPRX Compound	Shalimar, Shalicoat, Proprietary as per Insulation Mfg. Spec's
Adhesive for Closed Cell	Pidilite / Proprietary as per Insulation Mfg. Spec's
Underdeck Insulation - PIR	ASAWA, MechEasy, Zeco
<b>Acoustic Insulation</b>	
Glasswool	UP Twiga, Owens Corning, Lloyd insulation, Kimmco
Open Cell Nitrile Foam Rubber Insulation Class 1	Armasound Microban, K-fonic, Aerocell
Vinyl Sound Barrier (MLV)	Acoustical Surfaces, Armaflex, MMT Acoustix, EnviroTech, Texasound.
<b>Miscellaneous:</b>	
Vibration Isolators/Cushy Foot Mounts	Dunlop, Resistoflex, Kanwal, Mupro, Cori, Flexionics
Flexible Pipe Connection	Dunlop, Resistoflex, Kanwal, Mupro, Cori, Flexionics, Vimpa
Occupancy Sensors	Honeywell, Legrand
V-Belts	Dunlop, Fenner
Hardware	Sundaram Fasteners, GKW, Fittight
Anchor Fasteners	Shakti, Hilti
Wire supports	Gripple, Hilti, GPL
Paint	Nerolac, ICI, Asian, Berger
Welding Rods	ESAB, Advani-Orlecon
Water Storage Tanks, Expansion Tank	Sintex, Surya
Intertia Bases	Kanwal
Aircurtains	Euronics, Systemair, Mitsubishi, VTS

<b>ITEM</b>	<b>APPROVED MAKES</b>
Passivation System for CHW / CDW/Hotwater	Chemtex, Thermax, Nalco, Biocide
Dry Scrubber	Trion, Rydair, Ensavior
Sequential Controllers	Vemco, Microcool, Aircon Controls, Proton Controls
<b>MV Switchgear and Ancillaries:</b>	
MCB Distribution Boards	Havells, Legrand, L & T, Schneider, Indo Asian
Moulded Case Circuit Breaker	Legrand, L & T, Schneider, ABB, Havells, Indo Asian
Air Circuit Breaker	Legrand, L & T, Schneider, Havells
SFUs', Fuses & Fuse Bases	Legrand, L & T, Havells,
Miniature Circuit Breaker	Legrand, L & T, Schneider, ABB, Havells, Indo Asian
RCBO	Legrand, L & T, Schneider, ABB
Earth Leakage Relay / EFR	L&T, ABB, Areva
Relays: UV / Shunt / OC	L & T, Areva, Legrand, ABB
Contactors & Starters	L & T, Siemens, Schneider, ABB, Merline Gerlin
Current Transformer	AE, Kappa, Voltamp
Push Buttons	Teknik, L & T, Siemens
Indicating Lamps	Teknik, L & T, Siemens
Selector Switches and Rotary Switches	Legrand, L & T
Measuring Instruments	Legrand, L & T, AE, IMP, Meco, Rishabh
KWH Meters (EB Approved) / Load Manager (Model LG+1129 with RS 485 Make: Elmeasure)	Elmeasure, HPL, Secura
Cable Glands	Braco, Comet, Siemens, Dowel
Terminals	Elmex, Connectwell
GI Conduits (ISI Mark)	AKG, BEC, Universal, Asian
Unarmoured Cabling	Rajanigandha, RR, Polycab, KEI
Armoured Cabling	Rajanigandha, RR, Polycab, KEI, Kenter, Caliplast
Control Cabling	KEI, Polycab, RR, Rallision
Metal Conduit Accessories	PEI, Uma
Switches, Sockets, Plugs, Ceiling Rose, TV Outlet, Telephone outlets etc.	Legrand, Anchor Roma, Legrand Mosaic, MK India, L & T
Industrial sockets in enclosure with MCB	Legrand, BCH, L & T, Crompton, Siemens, Standard

<b>ITEM</b>	<b>APPROVED MAKES</b>
Bi-metallic Crimping Type Lugs	Dowells, Jainson, Siemens, Dowel, Comet
Cable Tray / Wireways / Trunking	Indiana, Profab, Asian, Bravo, Enjay
APFC Panel	L & T, PMX, Shreem
Power Capacitors	L & T, Meher, Crompton, Asian, Siemens, Shreem
Telephone Cables	Delton, ITL
Cat-5 Cable/ Cat 5 E Cable/Fiber Optics Cable / Cat-6	Lapp, Legrand, AMP, BELDON
Data / Voice Outlet RJ - 45	Legrand, Anchor, AMP, BELDON
Coaxial Cables	RR Kabel, Finolex, Caliplast
L V Transformers / Rectifiers / SMPS	Branded, Approved make
Timer Switches	Legrand, L & T
Outdoor type Isolators	Legrand, Schneider, L&T
L V Transformers / Rectifiers / SMPS	Branded, Approved make

## **5.0 MEASUREMENTS & PAYMENTS**

### **1.0 SCOPE**

1.1 The scope under this section covers the mode of measurements and payments for the HVAC System. The general requirements, break-up and mode of payment etc. shall be as specified under

### **MEASUREMENTS AND PAYMENTS:**

### **2.0 MEASUREMENTS**

<b>Sr No</b>	<b>Item</b>	<b>Item Included</b>	<b>Item Excluded</b>
<b>1.0</b>	<b>EQUIPMENTS</b>		
	Each equipment shall be measured as one unit and classified based on the type and capacity of equipment.	Complete unit with all components and accessories required for the specific duty	
<b>2.0</b>	<b>REFRIGERANT PIPING</b>		
	The pipes shall be measured on the basis of unit length (meter) and shall be classified based on the material and diameter.	Pipes with all fittings and accessories like coup-lings, tees, bends, reducers, nipples, flanges, plugs, bushes etc. supports and hangers	Nil
<b>3.0</b>	<b>AIR DISTRIBUTION</b>		
<b>3.1</b>	<b>DUCTS</b>		
	The ducts shall be measured on the basis of sq.m of surface area of the fabricated duct and shall be classified on the basis of the thickness of GI sheet.	GI sheet, fabrication stiffeners, flange connection, guide vane, splitters, opening for mounting collars, grills and diffusers, painted supports and hangers	Nil
<b>3.2</b>	<b>GRILLES &amp; DIFFUSERS</b>		
	The grilles and diffusers shall be measured on the basis of face area in sq.m.	Grilles and diffusers with flange, collar, damper for supply grilles & damper of neck size for diffusers.	Wooden / Al. frames to be included.
<b>3.3</b>	<b>DAMPERS</b>		
	The dampers shall be measured on the basis of sq.m. of face (cross sectional) area of that particular damper	Volume control damper, Motorised and Fusible link fire dampers, Motorised Dampers, Backdraft dampers and accessories.	Damper Actuators
<b>4.0</b>	<b>INSULATION</b>		
<b>4.1</b>	<b>FOR DUCTS</b>		
	The ducts insulation shall be measured on the basis of unit surface area (sq. m) of the bare duct and classified based on thickness of insulation.	Insulation, bonding cladding and fixing material	Nil
<b>4.2</b>	<b>WALL, FLOORS &amp; CEILING</b>		
	The wall, floors & ceiling acoustic insulation shall be measured on the basis of the surface area in sq.m of the surface insulated and shall be classified on the basis of thickness of insulation.	Insulation, bonding cladding and fixing materials and wooden framework	Nil
<b>5.0</b>	<b>ELECTRICAL WORK</b>		
<b>5.1</b>	<b>POWER PANELS</b>		
	Each power panel shall be measured as one unit.	Incoming & outgoing feeders, busbars indicating lamps and control instruments, internal wiring etc. with suitable switchgear as indicated in drawings.	Nil

Sr No	Item	Item Included	Item Excluded
5.2	<b>CONTROL PANELS</b>		
	The control panels along with the cabling shall form part of the equipment & hence no extra payment shall be made.	Control panel with instruments and indicators, piping and cabling	Remote start stop push button and connected cabling
5.3	<b>POWER CABLING</b>		
	The power cabling shall be measured on the basis of unit length of cable between the lugs at each end termination		Terminations.
5.4	<b>CABLE END TERMINATION</b>		
	Cable end terminations of both ends shall be measured as one unit	Glands, lugs	Nil
6.0	<b>MISCELLANEOUS</b>		
	The structural supports, hangers etc. shall form part of the item supported and hence no additional payments is applicable	Structural supports, grouting, red-oxide, primer, final painting, finishing etc.	Nil

### 3.0 MEASUREMENT FOR PAYMENT:

3.1 For insulated piping and drain piping, the measurements shall be based on per running meter basis and shall include insulation for various fittings such as flanges, elbows etc. No extra quantities shall be allowed for such fittings etc. However, each valve shall be counted as 1 meter of insulated pipe of the same diameter for the purpose of measurement.

3.2 For insulation of ducting the measurements shall be based on bare ducting surfaces and this shall be inclusive of insulation on flanges, elbows, supporting angles etc. For acoustic lining the insulation measurements shall also be based on bare duct areas.

3.4 For insulation on walls and exposed ceiling etc the measurements shall be taken on bare wall / ceiling floor surfaces. For beams and columns measurement shall be taken on finished surfaces, after insulation.

3.5 For grilles/diffusers etc. the measurements shall be based on the neck area of the unit.

3.6 Ducting shall be measured for the actual finished surface as per the surface developed. No allowance for cut outs, openings less than 1.0 sq. m. shall be considered. However, reduction in Insulation & ducting measurements for cut outs larger than 1.0 sq. m. shall be applied.



## **6.0 REFRIGERATION UNITS:**

### **A] AIR COOLED CHILLERS:**

Existing

## **7.0 PUMPS:**

Existing

## **8.0 VARIABLE SPEED DRIVES FOR SECONDARY CHILLED WATER VARIABLE PUMPING SYSTEM:**

Existing

## **9.0 WATER DISTRIBUTION**

### 1.0 SCOPE

1.1 The scope under this section shall cover supply, fabrication, assembling, laying, testing and commissioning of piping work required for HVAC installation.

### 2.0 STANDARDS

2.1 The piping work shall conform to the relevant standard indicated under each section.

### 3.0 GENERAL REQUIREMENTS

3.1 The pipe and pipe fittings shall be one of the recommended makes and best quality without any defects. The pipes shall be truly cylindrical.

The inside and outside surfaces shall be smooth with uniform wall thickness. The pipes and pipe fittings shall bear manufacturer's name and ISI marks and supplied along with manufacturer's test certificates.

3.2 The size indicated shall be clear inside diameter unless otherwise indicated. The pipes should withstand the test pressure for the various type and class of pipes indicated in the relevant IS specifications.

3.3 The pipes shall be suitable for the fluid, the temperature and the pressure of the fluid; it carries the system as a whole.

3.4 The pipe assembly shall be suitable for the service and pressure of the system. The assembly shall be totally leak proof and easy for maintenance. The fabrication shall conform to ANSI B 31.3.

3.5 Necessary flanged joints and control valves shall be incorporated in pipe for easy maintenance, replacement and isolation of section of pipes. The flanged joints shall be with 3 mm neoprene gasket, or fibre reinforced PTFE suitable for the pressure and temperature of the fluid.

3.6 The pipes shall be laid in lines and levels indicated on the drawings. The vertical risers shall be properly secured to the building structure with necessary clamps. The horizontal runners shall be hung from the ceiling using pipe hangers or laid on structural steel racks.

3.7 Supports shall be provided at the assembly or valves and control accessories, change in direction of pipes etc. in addition to the supports specified.

3.8 Neat appearance and good workmanship with provision for easy maintenance shall be consideration. Pipes shall be cleaned thoroughly and cleared off all foreign matters before taking up the assembly.

3.9 Adequate slopes are to be provided for drainage lines, steam lines etc.

3.10 The inside and outside surface of the pipe, and fittings shall be thoroughly cleaned before and after the fabrication work.

3.11 All fabricated piping shall conform to the fabrication dimensional tolerance specified in the code for pressure piping, ANSI B 31.3 and shall in any case be not more than the following.

- a) Individual tolerance: + 1.5 mm
- b) Overall tolerance: + 3.0 mm

3.12 All piping work shall be provided with protective coating as specified separately in this section.

#### 4.0 MATERIAL

4.1 The material for pipes and valves for various utilities shall be as shown systems and material and the schedule of material.

#### 5.0 M.S. PIPES

5.1 The M. S. pipes and fittings shall conform to the following standard specifications.

- a) IS: 1239 Mild steel tubes, tubular and other wrought steel fittings (part 1 & 2)
- b) IS: 3589 Electrically welded steel pipes for water gas and sewage (150 mm to 2000 mm nominal size)
- c) IS: 1839 Malleable iron GI fittings

5.2 The M.S. pipes shall be of ERW medium or heavy class suitable for welded joints.

5.3 The fittings shall be heavy quality M.S. and shall be suitable for welded joints.

5.4 The fittings upto 50 mm dia may be fabricated out of pipes.

5.5 All fittings above 50 mm shall be forged steel or ERW heavy quality suitable for welded joints. The flanges shall be slip on type with plane faces conforming tot IS: 6392 and rated for 1.0 N/sq.m.

5.6 The steam and refrigeration suction piping shall be with M.S. seamless pipe minimum Schedule 40.

#### 6.0. GI PIPES

6.1 The GI pipes and pipe fittings shall conform to the following standard specification.

- a) IS: 1239 Mild steel tubes, tubular and other wrought steel fittings (Part 1 & 2)
- b) IS: 3589 Electrically welded steel pipes for water gas and sewage (150 mm to 2000 mm nominal size)
- c) IS: 1839 Malleable iron GI fittings
- d) IS: 2629 Recommended practice for Hot dip galvanising of iron & hot steel
- e) IS: 4736 Hot dip zinc coatings for steel tubes

6.2 The GI pipes shall be of ERW medium or heavy class with screwed ends as indicated in the schedule of work.

6.3 The fitting shall be heavy quality and shall include couplings, tees, bends, reducers, nipples and plugs.

6.4 The fittings shall be forged steel or ERW heavy quality hot dip galvanised and with screwed ends. The threading shall conform to IS: 554 unless otherwise specified. The flange shall be screwed type with full-faced gasket suitable for the pressure and the liquid.

#### 7.0 NON METALLIC PIPES

7.1 The non-metallic pipes and fittings shall be of PVC, UPVC or polythene conforming to the following standard specification.

- a) ASTM - D - 1785 For PVC pipes
- b) IS: 1239 (part I) For UPVC threaded pipes
- c) IS: 4984 For HDPE pipes
- d) IS: 4985 For PVC/UPVC pipes
- e) IS: 7384 For PVC fittings

7.2 The pipes shall be suitable for threaded joints/soldered joints. The wall thickness shall be suitable for the temperature and pressure of the fluid handled without any damage to the pipe and the chemical and physical properties and composition of the material.

#### 8.0 VALVES

8.1 The shut off valves for water circuit shall be globe upto 40 mm and butterfly for 50 mm and above provision for locking facility and or identification of opening of the valves after balancing shall be incorporated. Valves shall be PN-16 Rated unless specified separately.

8.2 The valves shall conform to the following standard specification and shall have minimum pressure rating of 1.0 N/sq.m.

- a) IS: 778 Gate, globe and check valves, copper alloy for water supply works
- b) IS: 780 Sluice valve for water supply works (50 - 300 mm size).
- c) IS : 4828 Check valves quick closing for centrifugal pump outlets
- d) IS : 5752 Metal valves for use in flanged pipe system.
- e) IS : 5155 Cast iron & carbon steel butterfly valves for general purpose.

8.3 Valves for control of steam shall meet the requirement of IBR and shall be of cast steel body with stainless steel internals.

8.4 The valves for condenser and chilled water circuit shall be with

- a) Gunmetal body with bronze or stainless steel internals
- b) Cast iron body with bronze or stainless steel internal

8.5 The polypropylene valves shall conform to IS: 4660.

8.6 All valves flanges shall conform to table E IS: 6392, IS: 6392, IS:1538.

8.7 Gate valves upto 50 mm NB shall be bronze/gun metal with solid wedge gate and flanged ends conforming to IS: 778-1971. Larger sizes shall have gray cast iron body to Gr 20 IS: 210 with gun metal internals and high tensile brass spindle and gun metal nut. The valve shall have flanged ends and a non - rising spindle and gun metal nut. The valve shall have flanged ends and a non - rising spindle and gun metal nut.

The valve shall have flanged ends and a non-rising spindle and conform to IS: 780-1980 upto 300 mm dia and IS: 2906 - 1969 for larger sizes.

8.8 Ball valves over 50 mm shall cast iron no lubrication full-bore valves with fine grain cast iron (Gr 20) body with mirror finished AISI 410 stainless steel ball, glass filled PTEE seats and stem seals.

Valves shall be suitable for control and drop-tight shut off and shall have flanged ends drilled as required. Ball valves for less than 50 mm NB shall be gunmetal with integral strainers with FPT inlet and MPT flared connection on the outlet.

8.9 Butterfly valves shall have a cast iron body with cast steel disc and spindle of stainless steel AISI 410. The valve shall be of wafer like and should be fitted with two slip on type pipe flanges. The valve shall have a moulded PTFE sleeve, which shall bring about 100% tight shut off at the design working pressure.

8.10 Non-return valves upto 50 mm NB shall be swing - type of gunmetal construction with flanged ends. Larger sizes shall be of cast iron construction with gunmetal internals.

8.11 Water strainers shall be either 'Y' or pot type with cast iron or fabricated steel bodies for specified test pressure. Strainers shall be complete with brass basket with 3 mm perforations, a dirt blow out plug and a permanent magnet. Strainers shall be designed for easy removal of strainer basket without dismantling the pipe shall have flanged end connections.

#### 9.0 FABRICATION, ASSEMBLY & LAYING

9.1 The fabrication, assembly and laying of pipes shall be conforming to the following standards.

- a) IS: 5822 COP for laying of welded steel pipe
- b) IS: 634 COP for plastic pipe work for potable water supply

9.2 The method of fabrication and assembling of various piping work shall be as shown below:

- a) M.S. pipe Butt or socket welded
- b) GI pipes Screwed assembly
- c) UPVC Screwed assembly
- d) Polyethylene Fusion welded

9.3 Pipe supports shall be of steel with a prime coat of red oxide and two finish coats of matt black paint after installation. Supports shall be spaced as follows:

SIZE	HORIZONTAL	VERTICAL
Upto 15 mm	1.25 m	1.8 m
20 to 25 mm	2.00 m	2.5 m
32 to 125 mm	2.50 m	3.0 m
150 & over	3.00 m	3.0 m

Additional supports shall be provided at the bends, at heavy fittings like valves, near equipment and as be from structural steel, steel inserts in concrete, adequate shear fasteners wall brackets or floor supports as decided by the Engineer-in-charge depending upon the location of the support.

Hangers shall not be secured to light weight roof, wall, false ceilings or any other member, which is not structurally meant for such loading.

Hangers from structural steel shall be from suitably designed clamps or attachments and in no case should drilling or punching of such steel members be allowed. All pipe supports shall be capable of being adjusted in height to the tune of 50 mm.

9.5 Pipe clamps shall be specially fabricated fittings for pipes. All clamps shall be of mild steel prime coated with red oxide and finish coated with matt black paint. Clamps shall take into account pipe movement owing to temperature variations & anchors, and in no case shall the clamping

arrangement induce stresses beyond the safe load limits of the pipe under fully filled conditions. Where pipes are insulated, the clamping shall interpose a hard insulation material or shall be designed so that the insulation is not compressed for more than 60% of its compression strength.

9.6 Vertical pipe risers shall be supported at each floor and in addition, the riser shall have duck-foot support.

9.7 Manual air vents shall be provided at all high points in the piping systems for air purging. Vent sizes shall be as follows and suitable for specified test pressure.

- Upto 152 mm (6"): 12 mm size globe type gunmetal valves with hose connections
- Over 152 mm (6"): 20 mm size globe type gunmetal valves with hose connection.

9.8 Drains shall be provided at all low points and all drain valves shall be gunmetal globe type with hose connections.

9.9 Pipes passing through walls & floors shall be provided with sleeves as follows:

SPACE	DIA (mm)	SLEEVE PROJECT- ION (mm)	SLEEVE MATERIAL	SLEEVE PACKING	SLEEVE & CLOSURE
Floor	D + 50	50	1.25 mm	32 kg/cum	GSS or bonded Light fibre duty glass with Galvanised 8 mm thick poly -sulphide walls
i) Internal D + 50		Flush	- do -	32 kg/cum	Resin bonded Fibreglass coated on both sides With 1.0 mm GSS split flange
ii) External D + 50		- do -	- do -		Caulked with lead wool and oakum & closed on both sides with 1.25 mm GSS split flange with brass screws

9.10 All piping shall be laid and tack welded in position with flanges, valves etc. After inspection and approval by the Engineer as to the alignment and height, the piping shall be full welded. Slip-on flanges shall be demounted for welding. Piping may be presented to the Engineer for such approval in sections. Random samples of valves shall be tested for leaks and seating. Necessary hand pump and blank flange facilities with pressure gauge, valves etc. should be provided at site.

#### 10.0 WELDED PIPE ASSEMBLY-CARBON STEEL

10.1 The pipe assembly shall be carried out by electrical arc welding conforming to ASME section IX, IS: 817 and IS: 9595

10.2 The welding electrodes with suitable coating shall be of reputed make conforming to IS: 814 and shall be got approved by the owner/consultants

10.3 Machine cut levels to form the welding groove are preferred but smooth, clean, slag free flame cut and ground levels and acceptable.

10.4 The pipes to be aligned and tack welded leaving a gap of 1.5 mm for pipes upto 150 mm dia and 3.0 mm for pipes above 150 mm dia for fuse penetration of welds before carrying out the permanent weld point. Tack welding lacking full penetration of welds before carrying out the permanent weld point. Tack welding lacking full penetration is not acceptable.

10.5 In case of multiple pass welding the slag shall be cleaned from previous layer lacking up the neat layer, the weld shall be cleaned freed from scale, slag, flex etc.

10.6 The finished weld shall be uniform and shall project not less than 1.5 mm or more than 3 mm from the outer surface of the pipe.

10.7 Pipe bends fabricated out by hot bending of pipes are acceptable upto 50 mm dia. The minimum radius of the bend shall be not less than 3 times the diameter and the bends shall be free of bulges, cracks, wrinkles, buckles etc.

#### 11.0 FUSION WELD ASSEMBLY - HDPE

The HDPE pipe assembly shall be done with butt-welding using 200 deg. C hot plate. After heating the ends to be welded they shall be done pressed against each other till uniform joint is obtained.

## **10.0 MOTIVE & TRANSMISSION EQUIPMENTS**

### **1.0 SCOPE**

1.1 The scope of this section covers motive equipments such as:

- a) Motors,
- b) Pulleys
- c) Drive belts

### **2.0 STANDARDS**

2.1 The following standards shall be applicable:

- a) IS: 325                    3 Ph. Induction Motors
- b) IS: 996                    1 Ph. small AC and universal electric motors
- c) IS: 900                    COP for installation & maintenance of induction motors
- d) IS:1231                    Dimensions of foot mounted induction motors
- e) IS: 2223                    Dimensions of flange mounted induction motors
- f) IS: 2253                    Type of construction and mounting of motors
- g) IS: 4029                    Guide for testing 3 Ph. induction motor
- h) IS: 4722                    Rotating electrical machinery
- i) IS: 4691                    Degree of protection provided by enclosure for rotating electrical machinery
- j) IS: 4728                    Terminal marking for rotating electrical machines
- k) IS: 3003                    Carbon brushes for electrical machines
- l) IS: 6362                    Designation of the method of cooling of rotating electrical machines
- m) IS: 3142                    V-grooved pulleys for V belts give sections A, B, C, D & E
- n) IS: 2949                    V belts for industrial purpose
- o) IS: 2122                    COP for selection, storage, installation and Maintenance of belts for power transmission
- p) ECBC standard for Motor Efficiency.

### **3.0 GENERAL REQUIREMENTS**

3.1 The motors and transmission equipments shall be suitable for the motive power required and the speed of the equipment to be driven.

3.2 For air handling equipments desired to run for 24 hrs. Shall be provided with 2 nos. motive and transmission equipment. Motor shall be of high efficiency.

### **4.0 MOTORS**

4.1 The motor shall conform to the details shown on the equipment data of the equipment driven and shall be designed for an average ambient of 45 degree C with a peak of 50 degree C. The motors shall be squirrel cage induction upto and including 200 hp unless otherwise indicated. The motors shall be suitable for continuous operation round the clock and statically and dynamically balanced to achieve smooth operation and low noise level. The enclosure shall be of cast iron having a minimum degree of protection as shown below for Refrigeration units & AHU's, Fans.

4.2 The stator and rotor cores shall be made out of high quality magnetic steel stampings of high permeability and low loss. The stator winding shall be with synthetic enamelled copper wire with slot insulation of minimum class F insulation. The rotor winding shall be of caged construction with

copper or copper alloy bars brazed to end ring of same material. The motors shall be with shaft-mounted fans for cooling the windings.

4.3 The shaft shall be of high-grade tensile steel suitable for heavy duty. The bearing at the free end shall be ball type at free end and roller type at the load end.

## 5.0 PULLEYS

5.1 The pulleys shall be of heavy duty M.S or Cast Iron with flat groves.

5.2 The pulleys shall have taper lock hub with 2 grub screws for tightening and 1 grub screw for loosening.

## 6.0 DRIVE BELTS

6.1 The drive belts shall be flat-belts suitable for industrial purpose. The size and number of belts shall be according to the power to be transmitted. The belt safety factor shall be not less than 2.5.

## 7.0 INSTALLATION

7.1 The motors shall be directly coupled to the equipment. However, indirect driven equipments are acceptable provided it is essential for the proper performance of the equipment and owing to the space restrictions.

7.2 The motor and the equipment shall be mounted on a common base frame. The direct driven equipments shall be provided with flexible couplings. The couplings and the belt and pulley assembly shall be provided with suitable safety guards.

## 8.0 TESTING

8.1 The motors shall be meggered to record a IR value of not less than 1 mega ohm. The direction of rotation of the equipment to be checked before putting the equipment to operation. The no load and full load currents to be recorded.



## **11.0 NOISE AND VIBRATION CONTROL**

### **1.0 SCOPE**

1.1 The scope under this section covers control of noise and vibration for the equipments and installation.

### **2.0 STANDARDS**

2.1 The following standards shall be applicable:

- a) IS: 1950 COP for sound insulation of non-industrial buildings
- b) IS: 3483 COP for noise reduction in industrial buildings
- c) IS: 4954 Recommendations for noise abatement in town planning.

2.2 In addition to the above standards any other standards prevailing and the general construction and installation practices shall be applicable for the control of noise and vibration.

### **3.0 GENERAL REQUIREMENTS**

3.1 The equipments and the installation shall be selected, designed and erected such a way that the noise and vibration is minimum where the noise level is high necessary precaution to be taken in the selection of the equipments and necessary acoustic treatment to be provided. Similarly where the vibration is high necessary isolator shall be provided to minimise the transmission of the vibration to the structure or other areas.

### **4.0 NOISE CONTROL**

4.1 The equipments shall be selected for low noise level especially on handling equipments. Fan and drive motors shall be statically and dynamically balanced and provided with proper bearings. The sound pressure level should not exceed NC 60.

4.2 The fan coil and air handling unit R.A plenum shall be acoustically insulated. The supply and return air ducts shall be acoustically insulated for a minimum length of 3m or as shown on the drawing with 25mm thick fibre glass crown 200 covered with 28 G perforated aluminium sheet. The sheet metal duct shall be increased accordingly to accommodate the insulation and get a clear ducts size indicated on the drawings.

4.3 The acoustic treatment of equipment rooms shall be by providing acoustic insulation of walls and ceiling as shown on the drawing. Resin bonded glass wool of 32-kg/cu.m density and 50 mm thickness shall be laid over bitumen bonding and wooden framework covered with 50% perforated 28 SWG GI sheets of 3 mm perforation.

4.4 **ACOUSTIC LOUVERS:** All openings in the wall and ceiling or those behind the return air grills in cabins, conference rooms, training halls shall be provided with 30/50 mm deep 3-bend (multiple louvers) GI sheet

22 SWG stuck with 25 mm thick resin bonded fibreglass covered with 22 SWG perforated aluminium. The space between adjacent louvers shall not exceed 70 mm.

The excess of the area of the continuous return air grill shall be blanked-off with 22 SWG sheet and painted black.

4.5 The velocity of air inside the ducts shall be limited to 9 m/sec. for main ducts and 7.5 m/sec. for branch ducts. The grilles shall be selected such that the noise pressure level should not exceed NC 35 for conference, meeting and guest rooms, NC 55 for open areas.

#### 5.0 AIR TIGHT DOORS

5.1 The air handling equipment room shall be provided with air tight doors. The doors shall be made of 14 SWG MS frame and 50 mm hollow door panels of 16 SWG MS filled with normal density resin bonded glass wool. There shall be double acoustic seal at the hinged side of the door and single seal at the other sides. The latch shall be positive pressure with adjustable strike and push rod release. The leakage shall not exceed 0.2 cmh/ sq.m.

#### 6.0 VIBRATION CONTROL

6.1 The equipments shall be statically and dynamically balanced and shall be provided with necessary concrete foundation. The equipments shall be fixed to the foundation/floor through vibration isolators.

6.2 The pipe connection to the pumps and other vibrating equipments shall be through flexible connection and necessary flexible hangers shall be provided for the pipe support near the equipments.

6.3 The duct connection to the air handling equipments shall be through double canvas connection or other flexible connection.

6.4 The equipment foundation shall be provided by other agencies based on the foundation drawing furnished by the air conditioning contractor. Necessary supervision during the construction of foundation and grouting of anchor/foundation bolts etc. shall be the responsibility of the air conditioning contractor.

## 12.0 THERMAL INSULATION

### 1.0 SCOPE

1.1 The scope under this section covers thermal insulation of pipes, ducting, roof and walls.

### 2.0 STANDARDS

2.1 The following standards shall be applicable:

- a) IS:7240 COP for application and finishing of thermal insulation material at temp. between 80 deg.C to 40 deg.C.
- b) IS:7413 COP for application and finishing of thermal insulation material at temp. between 40 deg.C to 700 deg.C.
- c) IS: 10556 COP for storage and handling of insulation material
- d) IS: 3346 Method of determination of thermal conductivity of thermal insulation material
- e) IS: 3690 Specification for glass wool mats for thermal insulation
- f) IS: 4671 Specification for expanded polystyrene for thermal insulation purposes
- g) IS: 8183 Specification for bonded mineral wool
- h) IS: 702 Specification for industrial bitumen

### 3.0 MATERIALS

**DUCT & PIPE INSULATION – MATERIAL – EPDM** The EPDM (Ethylene Propylene Diene Monomer) closed cell tube & sheet insulation shall be made confirming to ASTM, UL & other applicable standards with following properties:

Thermal Insulation of Ducts: EPDM Closed Cell Elastomeric Foam in roll / sheet form of minimum density 40 kg/m<sup>3</sup>, thermal conductivity-0.037 W/mdeg. K, Confirming to ASTM E 84 / Class 'O' fire category, Thickness -9,12-13, 15, 19, 25mm or 30, 40 OR 50mm thick as specified in the BOQ for supply and return ducts as indicated / specified in the dwg & BOQ.

The specifications are as below:

PHYSICAL PROPERTIES		AEROFLEX				TEST METHOD	
Cell Structure		Closed Cell				-	
Density lbs/ft <sup>3</sup> (kg/m <sup>3</sup> )		3-6 (48-96)				ASTM D 1667	
Thermal Conductivity	Mean	-4°F	32 °F	75°F	90°F	104°F	ASTM C 518, C 177 °
BTU.in/ft <sup>2</sup> hr. °F (W/mk)	Temp.	(-20 °C)	(0 °C)	(24 °C)	(32 °C)	(40 °C)	JIS A 1412
							DIN 52613
	K-value	0.22	0.23	0.25	0.26	0.27	
		0.032	0.034	0.037	0.038	0.039	
Service temperature		-70°F to 257°F -57°C + 125°C				AEROFLEX becomes hard at -57°.C, but can be used even at 200 °C	
Water Vapour permeability (g/Pa.s.m)		0.10 perm-in (1.44x10 <sup>-10</sup> )				ASTM E96	

Moisture Resistance		DIN 52615
( $\mu$ value)	$\mu$ 7000	
Water Absorption (% by weight)	5	ASTM D 1056
Ozone Resistance	No crack	ASTM D 1171, D 1149
Heat Stability (% shrinkage)	6	ASTM C 534
200 °F (93 °C) 7 days		
Flammability & smoke, Density	Class V O	UL – 94
	25/50	ASTM E 84
	Self – extinguishing	ASTM E 635
	Class 5.3	EMPA (Switzerland)
	Non-Flammable	JIS K 6911
	Pass	IMO
U.V. Weather Resistance	Excellent	-
Corrosion of copper, stainless	Non corrosive	DIN 1988
Nitrosamine Contents	Not Detected	U.S. FDA
Sound reduction ( $L_{AF}$ )	27 dB (20 mm)	DIN 52218
Flexibility	Excellent	-

Thermal Insulation of Pipes: EPDM Closed Cell Elastomeric Foam in pipe sleeves. Tube Insulation is a highly flexible, closed-cell and lightweight EPDM-rubber based elastomeric product. Tube Insulation is designed for insulating warm or cold piping, duct, or equipment. EPDM Elastomeric Tube Insulation is supplied in 6mm, 9mm, 12mm, 15/16mm, 19mm, 25mm, 32mm/40mm, 50mm, 65mm and 80mm thicknesses and popular I.D. sizes up to 200mm IPS. The tightly formed, closed-cell structure of EPDM Tube Insulation is suitable for all applications

Self-Seal with Protape (SSPT) to be used for sealing all joints to maintain self-seal,  
Thermal Conductivity: 0.245  
Water Vapor Transmission, Perms: 0.03  
UV Resistance: Minimal change, ASTM G 7 and ASTM G 90  
Fire Rating: Will not contribute significantly to fire (simulated end-use testing).

Tube Insulation, in 6mm through 50mm thickness, has a flame spread rating of 25 or less and a smoke developed rating of 50 or less as tested by ASTM E 84 "Surface Burning Characteristics of Building Materials." EPDM Pipe Insulation is acceptable for use in air distribution systems including ducts, plenums, air handling equipment and air terminal devices.

#### APPLICATION OF EPDM CLOSED CELL INSULATION

##### Before assembly

For pipe size up to 4" dia (115mm), Slip Closed Cell insulation tube over the pipe. The thick and smooth inner skin is coated with talcum powder for speeding up slipping even around most bends of the pipe. Apply brush coating of manufacturer recommended adhesive to both butt ends to be joined. Allow the adhesive to set until non-tacky to the touch (approx, 5-15 minutes) then press the joints together firmly.

##### Fitting

Closed Cell insulation tube is to be cut and fabricated for tees, elbow, crosses and all other fitting forms on preassembled lines. Use a clean and sharp knife to cut the insulation to the desired shape, depressing the insulation as little as possible to avoid irregular cuts. The commonly used fittings shall require only 450 and 900 cuts. A miter box should be used for more accurate cuts but careful free-hand cuts will also be allowed

for faster and more convenient on job- site insulation. After fabricated fitting covers are done, snap fitting cover in place over a fitting and then apply brush coating of manufacturer recommended adhesive to all joint surfaces. Allow the adhesive to set until non- tacky to the touch (approx. 5-15 minutes), press the joints together firmly.

#### For Existing Line

To insulate existing lines, slit Closed Cell insulation tube lengthwise on one side, or use Closed Cell precut sheet for above 3"dia (90mm I.D.), and snap over the pipe then seal lengthwise- slit surface and butt joints with manufacturer recommended adhesive. To assure a complete seal, avoiding loss of insulation efficiency, all joint surfaces must be fully and thinly coated with adhesive. Tape should not be used on seams and joints because tape is less effective than adhesive and may allow passage of moisture and air.

#### For Large Pipes and Irregular Shape

For applications that cannot be accomplished by preformed tubular insulation, like large piping, tanks and vessels, cut the insulation sheet in a measured size with a clean sharp knife. Apply manufacturer recommended adhesive on both surfaces to be insulated. Allow the adhesive to set non-tacky to the touch (5-15 minutes), press the sheet tightly against the surface to be insulated. Be sure it is in the desired position before the adhesive coated surface makes an initial contact since the adhesive forms an instant bond and repositioning after contact is difficult. Then seal both sheet rims with Aeroseal adhesive.

### APPLYING INSULATION FOR CHILLED WATER SYSTEM

Apply CPRX compound uniformly at 1.5 kg/sq.m on the pipe surface and internal surface of the insulation pipe section, hold them together and apply pressure till the bond is made. Additional layers shall be done on similar basis by applying CPRX on the outer surface of previous layer of insulation and the internal surface of the additional layer. All joints on vertical as well as horizontal shall be staggered.

A vapour seal of hot bitumen at 2.5 kg/ sq.m shall be applied uniformly on the final surface and finished smoothly with aluminum foil. Pairs of semicircular wooden supports shall be provided for fixing the pipes. There is no need of additional foil insulation sections are with aluminum foil finish.

The chilled water exposed to ambient shall be clad with shalikota or 4mm PYPKOTE. All chilled water piping shall be covered with 26 G Al. cladding for the entire piping.

### DUCT INSULATION – MATERIAL – CLOSED CELL NITRILE FOAM

Insulation material shall be Closed Cell Elastomeric Nitrile Rubber. Thermal conductivity of elastomeric nitrile rubber shall not exceed 0.033 W/(m.K) at mean temperature of 0°C. Insulation material shall have anti-microbial product, which is EPA (Environmental Protection Agency), USA approved, as an integral part of insulation which cannot be washed off or worn off. It shall give enhanced level of protection against harmful Microbes such as bacteria, mold, mildew and fungi and shall confirm to following standards: Fungi Resistance – ASTM G21 and Bacterial resistance – ASTM G 22 / ASTM 2180.

The insulation shall have fire performance such that it passes Class 1 as per BS476 Part 7 for surface spread of flame as per BS 476 and also pass Fire Propagation requirement as per BS476 Part 6 to meet the Class 'O' Fire category as per 1991 Building Regulations (England & Wales) and the Building Standards (Scotland) Regulations 1990. Material shall be FM (Factory Mutual), USA approved. Moisture Diffusion Resistance Factor or 'μ' value shall be minimum 10,000.

External thermal insulation shall be provided as follow:

The thickness of the nitrile rubber shall be as shown on drawing or identified in the schedule of quantity. Following installation procedure shall be adopted:

Duct surfaces shall be cleaned to remove all grease, oil, dirt, etc. prior to carrying out insulation work. Measurement of surface dimensions shall be taken properly to cut closed cell elastomeric rubbers sheets to size with sufficient allowance in dimension. Material shall be fitted under compression and no stretching of material shall be allowed. A thin film of adhesive shall be applied on the back of the insulating material sheet and then on to the metal surface. When adhesive is tack dry, insulating material sheet shall be placed in position and pressed firmly to achieve a good bond. All longitudinal and transverse joints shall be sealed as per manufacturer recommendations. The adhesive shall be strictly as recommended by the manufacturer. The detailed Application specifications shall be as per the manufacturer's recommendation.

Installation of Ducts Exposed Directly to Sunlight:

For installations exposed to sunlight, after giving 36 hours curing time for the adhesive apply manufacturer's recommended UV/Mechanical Protection. Please refer the separate detailed guidelines on UV/Mechanical Protection.

## **PIPING INSULATION**

### **MATERIAL**

Insulation material shall be Closed Cell Elastomeric Nitrile Rubber. Thermal conductivity of elastomeric nitrile rubber shall not exceed 0.035 W/(m.K) at an average temperature of 0°C.

The insulation shall have fire performance such that it passes Class 1 as per BS476 Part 7 for surface spread of flame as per BS 476 and also pass Fire Propagation requirement as per BS476 Part 6 to meet the Class 'O' Fire category as per 1991 Building Regulations (England & Wales) and the Building Standards (Scotland) Regulations 1990. Material shall be FM (Factory Mutual), USA approved. Moisture Diffusion Resistance Factor or 'μ' value shall be minimum 7,000. Thickness of the insulation shall be as specified for the individual application.

All chilled water, refrigerant and condensate drain pipe shall be insulated in the manner specified herein. An air gap of 100 mm shall be present between adjacent insulated surfaces carrying chilled water or refrigerant and also between the insulated surface and the wall to allow natural ventilation without affecting its external surface coefficient of heat transfer. Before applying insulation, all pipes shall be brushed and cleaned. All Pipe surfaces shall be free from dirt, dust, mortar, grease, oil, etc. Nitrile Rubber insulation shall be applied as follows:

Insulating material in tube form shall be sleeved on the pipes.

On existing piping, slit opened tube of the insulating material (slit with a very sharp knife in a straight line) shall be placed over the pipe and adhesive shall be applied as suggested by the manufacturer. Adhesive must be allowed to tack dry and then press surface firmly together starting from butt ends and working towards centre. Wherever flat sheets shall be used it shall be cut out in correct dimension. All longitudinal and transverse joints shall be sealed as per manufacturer

recommendations. The insulation shall be continuous over the entire run of piping, fittings and valves.

All valves, fittings, joints, strainers, etc. in chilled water piping shall be insulated to the same thickness as specified for the main run of piping and application shall be same as above. Valves bonnet, yokes and spindles shall be insulated in such a manner as not to cause damage to insulation when the valve is used or serviced. The detailed application specifications are as mentioned separately. The manufacturer's trained installer shall only be used for installation.

**RECOMMENDED ADHESIVE:**

In all cases, the manufacturer's recommended Adhesive shall be used for the specified purpose. All Adhesives, Sealants shall be LEED compliant with necessary documents as required for LEED submission.

**PUMP INSULATION**

Chilled water pump shall be insulated to the same thickness as the pipe to which they are connected and application shall be same as above. Care shall be taken to apply insulation in a manner as to allow the dismantling of pumps without damaging the insulation.

**SHELL INSULATION**

The chiller shells shall be factory / site insulated in accordance with the manufacturer's standards.

**COLD WATER AND EXPANSION TANK INSULATION**

Cold water tank, and chilled water expansion tank shall be insulated as per manufacturer's standard.

**Pipe Supports**

All pipe supports shall be factory made as per detailed specification attached

**INSTALLATION EXPOSED DIRECTLY TO SUNLIGHT:**

For installations exposed to sunlight, after giving 36 hours curing time for the adhesive apply manufacturer's recommended UV/Mechanical Protection. Please refer the separate detailed guidelines on UV/Mechanical Protection and choose the right product, as needed for specific requirement.

THICKNESS SELECTION CHART FOR NITRILE RUBBER INSULATION				
Design Basis: Condensation Control				
Location	Pune			
This thickness may be taken for other cities as well. For specific city requirement one may contact manufacturer.				
FOR OUTDOOR, ATTIC & UNCONDITIONED SPACES VENTED TO OUTDOOR				
Design Conditions: 28.3 Deg. C & 85% RH (as per ASHRAE guidelines)				
CHILLED WATER PIPING LINE TEMP 7 Deg.C				
Pipe NB (mm)	Required Thickness (mm)			
25 to 40	32			
50 to 150	38			
200 to 600	44			
Cold Water Tank	44			
REFRIGERANT PIPING				
LINE TEMP 3 Deg C				
Pipe NB (mm)	Required Thickness (mm)			
Up to 50	38			
Up to 100	44			
DUCT INSULATION				
	Required Thickness (mm)			
Supply Air Duct (Line Temperature 14 Deg. C)	23			
Return Air Duct (Line Temperature 22 Deg. C)	8			
THICKNESS SELECTION CHART FOR NITRILE RUBBER INSULATION				
Design Basis: Condensation Control				



INDOOR (CONDITIONED / SEMICONDITIONED AREAS)				
Design Conditions: 26.1 Deg.C & 85% RH				
CHILLED WATER PIPE LINE TEMP( 7 Deg.C)				
Pipe NB (mm)	Required Thickness (mm)			
Up to 65	19			
Up to 600	25			
DRAIN PIPING				
LINE TEMPERATURE 15 Deg.C				
Pipe NB (mm)	Required Thickness (mm)			
Up to 50	13			
REFRIGERANT PIPING				
LINE TEMP 3 Deg C				
Pipe NB (mm)	Required Thickness (mm)			
Up to 40	25			
Up to 100	32			
DUCT INSULATION				
	Required Thickness (mm)			
Supply Air Duct (Line Temperature 14 Deg. C)	18			
Return Air Duct (Line Temperature 22 Deg. C)	8			
Supply Air Duct in Return Air Path (Line Temp. 14 Deg.C)	8			

## ACOUSTIC INSULATION

### MATERIAL:

Material shall be engineered Nitrile Rubber open cell foam. The Random Incidence Sound Absorption Coefficient (RISAC); tested as per ISO 354, shall be minimum as per enclosed chart:

Freq	125	250	500	1000	2000	4000	NRC
10	0.03	0.04	0.14	0.04	0.88	1.00	0.35
15	0.01	0.09	0.29	0.74	1.08	0.83	0.55
20	0.04	0.13	0.4	0.9	1.04	0.90	0.60
25	0.02	0.25	0.86	1.14	0.88	0.99	0.80
30	0.07	0.32	0.99	1.16	0.93	1.08	0.85
50	0.23	0.73	1.29	0.99	1.09	1.11	1.05

- The material shall be fibre free
- The density of the same shall be within 140-180 Kg/m<sup>3</sup>

- It shall have Microban; antimicrobial product protection, and shall pass Fungi Resistance as per ASTM G 21 and Bacterial Resistance as per ASTM G 22, from an independent testing agency.
- The material shall have a thermal conductivity not exceeding 0.047 W/m.K @ 20 Deg. C
- The material shall withstand maximum surface temperature of +850C and minimum surface temperature of -200C
- The material shall conform to Class 1 rating for surface spread of Flame in accordance to BS 476 Part 7 & UL 94 (HBF, HF 1 & HF 2) in accordance to UL 94, 1996.
- The insulation shall pass Air Erosion Resistance Test in accordance to ASTM Standard C 1071-05 (section 12.7), from an independent accredited testing agency.

Thickness of the material shall be as specified for the individual application. The insulation shall be installed as per manufacturer's recommendation.

#### DUCT ACOUSTIC LINING

Ducts so identified and marked on Drawings and included in Schedule of Quantities shall be provided with acoustic lining of acoustic insulation material for a distance of minimum 5 meters (or 30% of the duct length whichever is more).

#### Installation Procedure

The inside surface for the ducts shall be covered with adhesive recommended by the manufacturer. Cut Foamed sheets into required sizes apply adhesive on the foam and stick it to the duct surface

#### ACOUSTIC LINING OF MECHANICAL ROOMS

The walls and ceiling of air conditioning plant room and air handling unit rooms may be provided with acoustic lining. The recommended insulation thickness is 30 mm. May be changed as per individual application requirements.

#### Installation Procedure

The wall surface shall be cleaned and required surface preparation shall be done for applying adhesive. Rubber based contact adhesive recommended by the manufacturer shall be used. The foam sheets shall be cut to required size and a thin layer of adhesive shall be applied to both the surfaces; wall and insulation. When it is tack dry, it is applied / stuck with enough pressure to the walls/ceiling. Minimum 5 fasteners with washer (of G.I Sheet 2.5 inch x 2.5 inch) / square meter, 4 at corners & 1 at centre shall be put immediately after sticking with the help of adhesive. The length of the fastener shall be minimum 75 mm.

## INSULATION ACCESSORIES

### UV / Mechanical Protection for Piping / Ducting / Vessel

#### Covering... With Polymeric Covering for Mechanical & UV Protection Arma-Chek R - Standard Specification Clauses

##### Specification:

For protection against mechanical impact and UV attack Arma-Chek R, non-metallic flexible polymeric barrier -- with a high resistance to Oil and Chemicals - should be applied.

##### Technical Details:

Colour: Black / Grey

Temperature Range: - 50°C (-200 °C) to +110°C If based on Class O Armaflex (acc. to EN 14706, EN 14707 and EN 14304))

Moisture Resistance Factor 'μ': 50,000

Density: 1600 kg/m<sup>3</sup> +/-100 kg/m<sup>3</sup>

Tensile Strength according to EN ISO 1798: 5.0 Mpa +/-1 MPa

Tear Strength according to ISO 37: 2.5 N/mm

Elongation according to ISO 37: Black 450-650% / Grey 150-250%

Fire Performance: Euroclass E (acc. To EN 11925-2)

UV Resistance: Very Good. Suitable for Outdoor applications.

Dust & Fibre Free

Colour: Black / Grey

##### Application Notes:

Covering should be cut to size according the circumference of the insulated pipe – please allow an additional 50 mm for the overlap of the covering material. The Overlap shall be securely fixed using Adhesive. All seam and joint details shall be over covered with Arma-Chek Mastic.

Spread thin film of Adhesive on the 50 mm overlap and the corresponding face to be adhered to and close the seam. For covering butt joints use Mastic. When covering fittings, please consult the Application Manual. All fittings have to be covered to the same standards as the covering of the pipe work. No additional vapor barrier is needed.

For further guidance please consult the » Application Manual.

Note: Above Adhesive & Mastic shall be manufacturer supplied / recommended.  
Application Manual means manufacturer's application manual.

## Treated Woven Glass Cloth covering for Mechanical & UV Protection

### Arma-Chek GC - Standard Specification Clauses

#### Specification Clause:

For protection against mechanical impact and UV protection, insulation manufacturer supplied Treated Woven Glass Fibre Covering - shall be applied.

#### Application Areas:

Chilled Water Piping, tanks and HVAC Ducts.

#### Technical Details:

Temperature Range: 0°C to +105°C Overall (irrespective of the base product)

Colour: Black/white

Treatment: Shall be treated Water Based Acrylic binder to give crisp and non-piling property to the fabric, to help in easy installation, minimize fiber erosion, good aesthetics and resistance to abrasion. Fibre spillage / Thread raveling should be minimum.

Density: 200 +/- 20 gsm

Tensile Strength: 275 +/- 25 Kg / 50 mm (minimum)

Thickness: 0.18 mm / 7 mill

#### PSA Tape:

Type: Solvent based Acrylic Adhesive

Peel Strength: 1000 gm / 25 mm (minimum) - (Adhesive to steel)

Release Liner: Polyester : Application Notes:

The covering should be cut to size according the circumference of the insulated pipe (allow an additional 50 mm for the overlap of the covering material). The Overlap shall be securely fixed using manufacturer's recommended Adhesive. It is recommended to use Mastic on all seams and joints. For external application (outdoors) use of Mastic, is mandatory in addition to the adhesive.

Spread thin film of manufacturer recommended adhesive on the 50 mm overlap and close the seam. When covering fittings, please consult the Application Manual. All fittings have to be covered to the same standards as the covering of the pipe work. No additional vapor barrier is needed.

For further guidance please consult the » Application Manual.

Note: Above Adhesive & Mastic shall be manufacturer supplied / recommended. Application Manual means manufacturer's application manual.

## Silver Metal Finish Flexible Covering for Mechanical & UV Protection

### (ArmaChek Silver 350 Standard Specification Clause)

Protective coverings shall be installed on areas of insulation that are exposed to weather, subject to mechanical damage or visible to building occupants.

Specification clause:

The surface covering shall be made from a 3-layer composite film of metallic appearance with aluminum intermediate layer and UV protection. Material shall be 350µm in thickness, with a total weight  $\geq 500$  g/m<sup>2</sup>, and on pipe sections have a permanent curl. The material shall be Class B (GB 8624), Class 0 (BS 476) and have a Flammability Index  $\leq 5$  (AS1530.2).

Cladding shall be installed with 30mm – 50 mm overlaps on all horizontal and longitudinal joints.

On outdoor applications, joints along the material length shall be installed facing downward. The joints shall be secured with plastic rivets in the overlap area, installed every 200 mm along the material length. Manufacturer recommended adhesive can be used for flat sheets, or where restricted access prevents use of rivets. All joints and overlaps must be finished with manufacturer recommended PSA Tape.

All bends, T-sections and end caps shall preferably be clad with thermoformed fittings of composite covering system. For fittings of an unusual shape, or large size, the cladding material should be cut and installed as per traditional metal cladding.

ADHESIVE (Shall be suitable for LEED requirements)

Factory made Elastomeric Nitrile Rubber Pipe Supports

Fire-stop penetration seal for pipes: (Armaflex Protect)

The flexible fire stop pipe seal with a fire resistance of > 90 min. for non-combustible/combustible supply pipes and/or non-combustible waste pipes in solid ceilings/walls or light weight walls.

Create fire-resistant seals for pipe-work using closed-cell, flexible elastomeric insulation with intumescent effect

The material shall have following properties

Temperature Range: -50 Deg. C to +85 Deg.C

Thermal Conductivity: 0.05 W/(m.K) at 0 Deg.C

Water Vapour Diffusion Factor  $\mu > 10,000$

Reaction to Fire: B2 in accordance to DIN 4102

Fire reaction to structural element: Minimum R 90

(DIN EN 13501-2: 2008-01, section 7.5.8)

Installation:

The intumescent insulation is to be either sleeved over the pipe or slit and sealed using manufacturer's recommended adhesive. Longitudinal seams and butt joints are to be covered with nitrile rubber self-adhesive tape. The gap remaining between the insulation and the wall/ceiling is to be closed completely using mineral mortar. In lightweight walls, the gap is closed using loose fill within the wall and filler against the gypsum board (annular gap up to 50 mm).

The length of the intumescent insulation is to be determined depending on the pipe material and diameter according to manufacturer's recommendation as per the standard / test report for the R 90 test.

The Pipe diameters above 89 mm can be insulated with sheets which are additionally fixed with the binding wire (wound around 6 times per running meter). Binding of wire shall be done for tubes as well.

Installation with zero clearance between the insulated pipes is permitted in the area of penetration is permitted. In case of chilled water lines condensation aspect shall be considered.

Work shall be carried out in accordance with relevant testing standard / test report.

#### Project Support:

The manufacturer shall have Application Engineers to support the project execution for training of insulation installers and project inspection. Only manufacturer certified installers shall execute the job.

## **13.0 ELECTRICAL INSTALLATION**

### **1.0 SCOPE**

1.1 The scope of this section covers electrical installation connected with the air conditioning work.

### **2.0 STANDARDS**

2.1 The following standards shall be applicable in addition to the relevant standards indicated in the sub-section.

- a) IS : 732 COP for electrical wiring installation
- b) IS : 1646 COP for fire safety of buildings,(General) electrical installation
- c) IS : 5216 Guide for safety procedure & practice in electrical work
- d) Indian Electricity Act and Rules

### **3.0 GENERAL REQUIREMENTS**

3.1 The electrical work pertaining to the air-conditioning installation shall be the responsibility of HVAC contractor unless otherwise indicated. The electrical work shall conform to the relevant Indian Standards and the codes and regulation of local authorities.

### **4.0 ELECTRICAL PANELS**

4.1 The panels shall be cubicle, flush front free standing with individual feeders housed in separate enclosure and shall conform to IS: 8623, IS: 3072, IS: 2147, IS: 4047, IS: 2516, IS: 2529, IS: 3914 and IS: 5124. The ratings of feeders and accessories shall be selected for the full load current of the equipment or the feeder load. The indicating and measuring instruments shall be 144 x 144 square. All incoming and outgoing feeders shall be with phase indicating lamps and ammeters. The panel fabrication drawings shall be got approved before taking up the fabrication work.

HVAC MAIN PANEL : The sheet steel (CRCA) used for fabrication shall be of 2.0 mm for non-load bearing members and 2.5 mm for load bearing members. The panels shall be supplied with required base channels. The insulators shall be made of high epoxy resin moulding. The bus bars and cable chambers shall be housed in separate chambers. The busbar and cable chambers should be fitted with bolted covers with gaskets and should be shrouded to avoid direct access to live parts immediately after opening respective covers. The bus bars and jumper connections shall be insulated to full maximum operating voltage. The cubicle shall be designed for IP4X protection. The vermin proofing shall be such that the vermin cannot enter from one compartment to another/ busbar chambers. Neoprene gaskets shall be used for all doors, covers and openings.

The bus bars and connectors shall be made of high conductivity Aluminium. The busbars and their connections shall be capable of withstanding, without damage, the thermal and mechanical effects of through fault currents equivalent to the short time. Switchgear shall be designed for a bottom/top cable entry and the busbars preferably shall be located at top, unless otherwise specified.

All switch drives other than rotary switches shall be lockable in "OFF" position. Shutters shall be provided at busbar chamber cutout for closing the same when the withdrawable chassis of the modules are drawn out.

#### **1) Air Circuit Breaker (ACB's)**

The circuit breaker shall be capable of making and breaking the specified fault currents without straining or damaging any part of the switchgear. The breakers shall be air break, motor/manual operated (as specified in specific requirement sheet), and horizontal non draw out type.

- a) The circuit breaker shall be stored energy closing type, manual/electrically operated with tripping mechanism. The circuit breaker shall be provided with 4 NO + 4 NC (specifically for purchaser's use) of auxiliary potential free contacts required for indication, control, interlocking and other purposes. All contacts shall be wired to a terminal block.
- b) Circuit breakers with stored energy closing mechanism shall be capable of making the rated short-circuit current, when the stored energy is suitably charged by a spring.
- c) The ACBs shall be provided with microprocessor based comprehensive releases for protection against overload, short circuit and earth faults.
- d) The circuit breakers shall be suitable for locking in fully isolated condition.
- e) Following interlocks and features shall be provided so that:
  - a. Truck can be moved within panel only when CB is off.
  - b. CB can be closed only when the test (or) service limit switches permit.
  - c. Breaker compartment door cannot be opened when the CB is in Service/test position.
  - d. Breaker cannot be put in to service position with compartment door open.
  - e. Earth slide beyond the test position till trolley is drawn out.
- f) Closing and tripping coil shall operate satisfactorily under the following conditions of supply voltage variation:
  - Closing coils – 85% to 110% of rated voltage.
  - Trip coils – 70% to 110% of rated voltage.

## 2) MCCB's

- a) The MCCB's shall conform to the latest applicable standards.
- b) MCCB's in AC circuits shall be of three/four pole construction arranged for simultaneous four pole manual closing and opening. Operating mechanism shall be quick-make, quick-break type. The ON, OFF and TRIP positions of the MCCB shall be clearly indicated and visible to the operator. Operating handle for operating MCCB's from door of board shall be provided.
- c) The instantaneous short circuit release shall be so chosen by the SUPPLIER as to operate at a current in excess of the peak motor inrush current and a range of settings shall be provided for the Engineer-in-charge selection.
- d) MCCB terminals shall be shrouded and designed to receive cable lugs for cable sizes relevant to circuit ratings.
- e) MCCB's shall incorporate time delay devices to ensure that it will tolerate harmless transient overload unless this is well in excess of 25% of its rated value for a sustained period.

## 3) MCBs



Miniature circuit breakers for use on motor space heater control circuits shall comply with the requirements of applicable standards, unless otherwise mentioned

4) MOTOR STARTERS

a) Contactors:

- Motor starter contactor shall be of the electromagnetic type rated for uninterrupted duty as defined in applicable standard.
- Main contacts of motor-starter contactors shall be of silver plated copper.
- Contactors shall be of the double break, non-gravity type.

b) Direct-on-line starters

- Direct-on-line starters shall be suitable for Class AC-3 utilisation category as specified in applicable standards.

c) Thermal Overload Relays

- Starter shall be complete with a three element, positive acting, ambient temperature compensated, time lagged thermal overload relay with adjustable settings. The setting range shall be properly selected in accordance with the rating of the motor.

5) SWITCHES, FUSE, CONTACTORS.

a) The switches shall be with silver plated contacts and capable of breaking safely full load current of associated equipment. Switches shall be quick make and break type and capable of breaking the circuit even if the mechanism spring fails. barriers shall be provided to prevent inter phase arcing. Switches and contactors for motor feeder shall be adequately rated for motor duty (AC-3).

Wherever called or, the same shall be sized for capacitor switching. Fuses shall be HRC line type fuses shall be provided with plungers and shall be visible without removal of fuse from service. Fuse pullers shall be provided.

6) CURRENT TRANSFORMERS

a) The current transformers shall have synthetic cast resin insulation and be of the single phase type, with number of cores as per the specific requirements.

b) The primary & secondary connections shall be clearly labelled.

c) All current transformers shall have insulation level and short time rating as per main switchgear. All current transformers shall be dimensioned to carry continuously current of 120% of the rated current. The ratios shall be as per the specific requirements.

7) VOLTAGE / POTENTIAL TRANSFORMER (PT):

a) The voltage transformers shall be insulated for full voltage rating.

b) The PT shall have synthetic resin insulation and be of single phase type. Rated secondary voltage shall be  $110 V/\sqrt{3}$  unless otherwise specified.

PT shall be capable of withstanding thermal and mechanical stresses resulting from short circuit and momentary current rating of breaker/switches.

8) METERS, RELAYS AND OTHER ACCESSORIES:

- a) All relays shall be of switchboard pattern, back connected, drawout type suitable for flush mounting and fitted with dust tight cases and provided with flag indicators and hand reset devices. The relays shall conform to IS 3231 or BS 3950 and BS 142. A set of test block and test lead for necessary secondary injection tests shall be included. All relays in drawout cases shall have suitable spring loaded contacts for inserting test block.
- b) Relays shall be provided with hand reset type contacts. The flag indication shall be suitable for external hand resetting and mechanically interlocked to prevent falling when relays are subjected to vibration. The rating of the auxiliary contacts shall not be less than 10 amp at 240 V AC and 5 amp for 30V DC.
- c) Each incomer / feeder shall be equipped with relays as detailed in the specific requirements.
- d) All relays shall have the following features:
  - a) Shall be suitable for auxiliary supply, as indicated in the specific requirement.
  - b) Shall be of drawout type suitable for flush mounting.
  - c) All auxiliary relays shall be of semi-flush or surface mounting type.
  - d) All protective relays shall be provided with adequate number of self reset contacts and hand reset flag indicators.
- e) Wherever called for, APFC relays of adequate steps shall be provided in the PCC panels. Required CTs shall be provided in the incomer of the panels for feeding the APFC relay. The APFC relay shall be intelligent micro processor based type.
- f) The thyristorised capacitor panel shall form part of the PCC/MCC panel. The thyristorised capacitor panel shall consist of required no. of fuse switch, contactors, Aux. Contactors, timers and capacitors of specified rating.
- g) The scheme for capacitor feeders shall be suitable for Auto/ manual operation. In the auto mode, the capacitor feeders shall be controlled by APFC relay. In the manual mode the same shall be controlled by ON/OFF pushbuttons mounted on the front of respective feeders.
- h) Suitable timers shall be provided in the manual mode of operation to ensure that a capacitor is not switched ON immediately after switching OFF.
- i) Motor duty contactors shall be three pole air break electro-magnetic type suitable for making and breaking locked rotor current of the motor. The connection of the contactor shall be direct-on-line type. Reversible motor contactors shall be mechanically and electrically interlocked with each other. The contact material shall have anti-weld properties. 3 main contacts 2NO and 2NC auxiliary contacts shall be provided as a standard feature. The aux. Contact shall be rated for min. 5A at 240V AC and 1.5A at 110V DC. Over-load relays for the contactors shall be three element, compensated time lag, hand reset, and bimetallic thermal type with adjustable setting range. The relay shall have at least 1NO + 1NC change over contacts. The thermal overload relay shall have reset facility without opening the door. Required no. of aux. Relays/contactors shall be considered to suit the specific schematic requirement.

9) AMMETERS, VOLTMETERS, KW METERS, KWH METERS:

- a) These ammeter, voltmeter and KW meter shall be of moving iron static type. Ammeters for motor feeders shall be of extended scale type. The KW Meter and KWH meter shall be suitable for measuring unbalanced loads on a 3-phase, 4 wire system. The KW Meter, KWH meter and voltmeter shall operate on 415V 3 $\phi$ , 4 wires supply.

10) INDICATING LAMPS / PUSH BUTTONS:

- a) These shall be switchboard type, low power consumption, LED type lamps complete with necessary resistors. Lamps shall be provided with screwed translucent covers to diffuse light. The lamp covers shall preferably be unbreakable, moulded, heat resistant material and shall be provided with chromium plated bezels.

- b) Push Buttons shall be heavy duty, push to actuate type with coloured button and inscription marked with its function. Each push button shall have minimum 2 NO + 2 NC contacts or as required, rated 10 A at operating voltage. Push button shall be shrouded type except for emergency trip button (if provided) which shall be mushroom type for easy identification. Push button colour shall be as follows:

- |             |   |        |
|-------------|---|--------|
| a) Stop/off | - | Red    |
| b) Start/ON | - | Green  |
| c) Reset    | - | Yellow |
| d) Test     | - | Black  |

11) CONTROL WIRING:

- a) Stud type terminals with identification ferrules shall be used. Local dependent marking as well as remote end dependent marking may be indicated in the ferruling at terminal blocks. Interlocking type ferrules shall be used. All wires carried within the switchgear enclosure shall be HRPVC insulated and neatly arranged so as to be readily accessible and to be easily replaceable. Wherever necessary the wires should be run in cable troughs and the wiring should be routed so that the same remains away from areas where electrical flame or flash over may occur. No conduit or cables shall be carried through the bus bar chamber.

- b) The voltage transformer wiring shall be done by HRPVC insulated, 1100V grade multi stranded flexible copper conductor of size 1.5 sq.mm and all the current transformer and DC control wiring shall be of the same type of cable as specified above with conductor size of 2.5 sq.mm. The colour coding shall be as per IS 375.

- c) AC and DC wiring are to be distinguishable function wise, AC and DC terminals are to be separated by shrouded terminal separators.

- d) All spare contacts of switches / relays shall be wired upto the terminal blocks.

- e) 20% extra spare terminals shall be provided. All terminals shall be suitable for terminating 2 wires from bottom and top side of the terminal block. However not more than one wire shall be terminated from either side on any terminal.

- f) All CT wiring shall be terminated on shorting and disconnecting type terminals.

12. NAME PLATE:

- a) Suitable anodised aluminium name plate of 1.2 mm thick shall be provided on all the switchboards and individual compartments.

13. EARTHING:

- a) An earth bus of requisite section not less than 40mmx10mm copper strip, shall be provided. It shall extend throughout and solidly connect all panels in a line with proper terminals, at the end to connect to the station earthing system. The terminal arrangement at the ends shall be suitable for connection by 50x6 mm GI flat and shall be complete in the bimetallic washers etc.

14. CABLE CHAMBER:

- a) The position of the cable chamber shall be such that the cables can be safely taken and carried through one meter trench at the bottom of the switchgear line up and the jointing carried out in a convenient and satisfactory manner. The cable termination arrangement for multiple cables shall permit connection and disconnection of individual cables without disturbing the other cables. Each panel shall have a separate cable alley. Cable alleys shall consist of cable supporting arrangement so that the load of the cable does not act on the terminals. Special warning labels shall be provided on removable covers (or) doors giving access to cable terminals and busbars.

15. PAINTING

- a) All metal surfaces shall be thoroughly cleaned and degreased to remove mill scale, rust, grease and dirt. Fabricated structure shall be pickled and then rinsed to remove any trace of acid. The under surface shall be prepared by applying a coat of phosphate paint and a coat of yellow zinc chromate primer. The under surface shall be made free from all imperfections before undertaking finishing coat.
- b) After preparation of the under surface, the switchgear panel shall be spray painted with two coats of final paint. Colour shade of final paint shall be RAL 7032 (epoxy based). The finished panel shall be dried in staving oven in dust free atmosphere. Panel finish shall be free from imperfections like pin holes, orange peels, run off paint etc. The vendor shall furnish painting procedure details along with the drawings submission.
- c) All unpainted steel parts shall be cadmium plated or suitably treated to prevent rust corrosion. If these parts are on moving element, then these shall be greased.

16. LIST OF DRAWINGS

The supplier shall furnish the following drawings for the switchgear.

- a) Overall outline dimensions and general arrangement including plan, front elevation, rear & side elevations, clearances recommended in front and back.
- b) Switchgear layout plan including floor openings, fixing arrangements and loading details.
- c) Schematic control diagrams to cover controls, protection, interlocks, instruments, space heaters, etc., for each type of module.

- d) Detailed internal wiring diagram of each type of module, including terminal block numbers, ferrule numbers and the external cable connection designations.
- e) Itemised bill of material for each module, listing all devices mounted and also otherwise furnished like cable glands, indicating the Manufacturer's type, rating, quantity & special notes, if any.
- f) Inter panel interconnection wiring diagram including terminal numbers and ferrule numbers.
- g) Each type of protection relay and circuit breaker release characteristics.
- h) The supplier shall be entirely responsible for the correctness of the internal wiring diagrams.
- i) The supplier shall ensure that the characteristics of the CT's, fuses, protection relays, PT's and all other devices offered by him are such as to be suitable for the purpose for which they are intended.

## 17 TEST CERTIFICATES

Type test certificates of all standard component parts, e.g. contactors, breakers, switches, fuses, relays, CT's, PT's, and for the standard factory built assembly shall be submitted by the supplier.

## 18. INSTRUCTION MANUALS (After award of contract)

The supplier shall furnish specified number of copies of the instruction manual which would contain detailed instructions for all operational & maintenance requirement. The manual shall be furnished at the time of dispatch of the equipment and shall include the following aspects:

- a) Outline dimension drawings showing relevant cross-sectional views, earthing details and constructional features.
- b) Rated voltages, current, duty-cycle and all other technical information which may be necessary for correct operation of the switchgear.
- c) Catalogue numbers of all components liable to be replaced during the life of the switchgear.
- d) Storage for prolonged duration.
- e) Unpacking.
- f) Handling at site.
- g) Erection.
- h) Pre-commissioning tests.
- i) Operating procedures
- j) Maintenance procedures.
- k) Precautions to be taken during operation and maintenance work

The Contractor shall comply with the specification irrespective of the information included in the technical literature and catalogues.

### **SPECIFIC REQUIREMENT FOR LV INDOOR SWITCHGEAR**

1.0	System voltage	:	415V
2.0	No. of phase	:	Three
3.0	System frequency	:	50Hz

4.0	Voltage variation	:	$\pm 10\%$
5.0	Frequency variation	:	$\pm 5\%$
6.0	System Neutral Earthing	:	Effective earthed
6.1	Design ambient	:	50°C
7.0	Service	:	Indoor
8.1	Fault level (Sym.)	:	50kA for 1 sec
8.2	Fault level (Dyn.)	:	125kA (Peak)
9.0	Switchgear details		
9.1	Type	:	Metal enclosed, Compartmentalized
9.2	Degree of protection	:	IP4X
9.3	Thickness of sheet steel		
	a. Front	:	2.5mm thick CRCA
	b. Sides	:	2mm thick CRCA
9.4	Paint	:	Pebble Grey shade (RAL 7032)
9.5	Busbar material	:	Aluminium
9.6	Support insulators	:	Epoxy
9.6	Temperature rise	:	40° C rise above 50° C ambient
9.7	1 min. power frequency withstand voltage	:	2.5kV (rms)
9.8	Control voltage		
	For trip circuit and indication	:	30V DC
	For spring charging, space heater closing and space heaters	:	220V 1 phase AC
10.0	ACB Feeder		
10.1	Type	:	Electrically operated with manual draw-out facility / manually operated (refer related SLD)
10.2	Protection	:	Microprocessor based overload, short circuit and earth fault release and also refer

respective SLD for other relays.

10.3	Metering	:	Refer respective SLD
10.4	Indication		
	a. CB ON	:	1
	b. CB OFF	:	1
	c. CB AUTO TRIP	:	1
	d. CB Trip healthy	:	1
	e. DC supply fail	:	1
	f. CB "SERVICE"	:	1
	g. CB "TEST"	:	1
10.5	Aux. Relays		
	a. Lock out relay	:	1 No.
	b. Trip circuit Supervision Relay	:	1 No.
10.6	Aux. Components		
	a. CB ON PB	:	1
	b. CB OFF PB	:	1
11.0	Switch fuse Feeder		
11.1	Type	:	Fixed type combination fuse switch.
11.2	Protection	:	Fuse.
11.3	Metering	:	Refer respective SLD
12.0	Current transformer	:	To be provided wherever metering and protections are indicated.
13.0	Ratio	:	Refer respective SLD
14.0	VA burden	:	Refer respective SLD
15.0	Class	:	Refer respective SLD
16.0	Metering details		Refer respective SLD

## 5.0 CABLING

5.1 All cables shall be PVC insulated, sheathed and armoured cables with copper conductor upto 16 sq.mm and aluminium conductor of 25 sq.mm and above. The cables and the laying shall conform to IS: 4288/IS: 1255.

## 6.0 STARTERS

6.1 The starter selection shall be as indicated in the equipment data. The starters shall be totally enclosed air insulated metal clad conforming to IS: 5124, IS: 3914 and IS: 2959 and shall include

adjustable thermal OL relays, single phase preventors, under voltage protection and additional contactors for inter-locking arrangement, indicators and remote controls.

## 7.0 EARTHING

7.1 All electrical equipments, panels, starters, cabling and conduiting shall be earthened conforming to IS: 732 and IS: 3043. The main earth grid shall be provided by others. The earthing conductors shall be as shown below:

<b>Load</b>	<b>Earth conductor-GI</b>
Conduit & load upto 1 kw	2 nos. 10 SWG
2 to 10 kw	2 nos. 4 SWG
11 to 25 kw	2 nos. 12 x 2 mm
26 to 50 kw	2 nos. 20 x 3 mm
51 to 75 kw	2 nos. 25 x 3 mm
76 to 100 kw	2 nos. 20 x 6 mm
100 kw and above	2 nos. 25 x 6 mm

## 8.0 INSTALLATION & TESTING

8.1 The panels shall be provided with ISMC 75 base framework and grouted to the floor or the pedestal provided. Individual starters, control station etc. shall be provided with ISA 25 frame support and grouted properly. Cables and earthing shall be laid in rents indicated and shall be supported on cable trays and clamped. Cables and earthing laid on floor shall be through PVC pipe sleeves buried in the floor or in cable trench.

8.2 The electrical installation shall be tested as indicated is IS: 732 and IS: 3043. The IR values of panels and cables and the earth resistance shall be measured and recorded. The test reports shall be signed and submitted by the licensed electrical supervisor.



## **14.0 EQUIPMENT DATA**

### **1.0 SCOPE**

1.1 The scope under this section shall cover the basic data of equipments to be filled in by the tenderer for the equipment that he intends to supply from the approved makes.

1.2 The equipment data indicates the general and basic requirements. The equipment details especially the motor output etc. shall be as per the manufacturer.

### **2.0 STANDARDS & SPECIFICATIONS**

2.1 The equipments shall conform to the relevant Indian Standard specification and shall be as specified under Technical specification.

### **3.0 GENERAL REQUIREMENTS**

3.1 All equipments shall meet the details indicated in the equipment data and technical specification. The tenderer shall submit the detailed catalogues indicating technical details, physical dimensions, performance chart etc.

3.2 The equipments shall be new and free from defects and shall be supplied along with the manufacturer's test certificate, operation and maintenance manuals etc.

### **4.0 EQUIPMENT DATA**

4.1 The following are the equipment data sheet enclosed with the tender. The tenderer should fill-in all the data.

- 1) AHUs and FCUs